CLAIMS

1. A force detector having a function for detecting a strength of an applied external force, comprising:

a substrate;

an elastic deformable body which is disposed at a position opposed to the substrate, at least a portion of said elastic deformable body being made of material having elastic deformability, and said elastic deformable body displacing with respect to the substrate due to an elastic deformation caused by the applied external force;

a force detecting element disposed between said substrate and said elastic deformable body, and changes in a predetermined electrical characteristic due to a displacement of said elastic deformable body; and

a switching element including a pair of contacting electrodes and carrying out a switching function so that an electrical insulated condition is normally maintained between said pair of contacting electrodes, and when an external force with more than a predetermined strength is applied to said elastic deformable body, an electrical conductive condition is obtained between said pair of contacting electrodes in response to a deformation of said elastic deformable body;

wherein an electrical characteristic of said force detecting element is detected as an electric signal, when an electrical conductive condition is obtained on said pairs of contacting electrodes.

2. A force detector according to claim 1:

the detector including a detection circuit for detecting a change in an electrical characteristic of the force detecting element as an electric signal;

wherein said detection circuit selectively operates in two modes of a detection mode and a standby mode, said detection circuit performing a detecting function for outputting a change in said electrical characteristic as an electric signal when

said detection circuit operates in said detection mode, said detection circuit maintaining a standby condition waiting for a transition to said detection mode without performing the detecting function when said detection circuit operates in said standby mode, a power consumption in said standby mode being less than a power consumption in said detection mode; and

wherein said standby mode is selected when an electrical condition of the pair of contacting electrodes is an insulated condition, and said detection mode is selected when an electrical condition of the pair of contacting electrodes is a conductive condition.

3. A force detector according to claim 1:

wherein a pair of contacting electrodes included in the switching element are comprised of a contacting fixed electrode disposed on the substrate and a contacting displacing electrode disposed on the elastic deformable body, and when an external force with more than a predetermined strength is applied to the elastic deformable body, due to a deformation of the elastic deformable body, said contacting displacing electrode comes into physical contact with said contacting fixed electrode.

4. A force detector according to claim 1:

wherein the switching element includes a pair of contacting electrodes disposed on the substrate and a mediating electrode which comes into a condition to contact with both of said pair of contacting electrodes to make an electrical conductive condition between said pair of contacting electrodes, and

wherein said mediating electrode is disposed so that said mediating electrode is normally maintained to be contacted with neither of said pair of contacting electrodes, or contacted with either one of said pair of contacting electrodes, and when an external force with more than a predetermined strength is applied to the elastic deformable body, due to a deformation of the elastic deformable body, said mediating electrode comes

into a condition to contact with both of said pair of contacting electrodes.

5. A force detector according to claim 2:

wherein a capacitance element is used as a force detecting element, and the detection circuit detects a capacitance value of said capacitance element as an electric signal, said capacitance element comprising a detecting fixed electrode provided on the substrate and a detecting displacing electrode provided at a position on the elastic deformable body which is opposed to said detecting fixed electrode and at which a displacement occurs.

6. A force detector according to claim 2:

wherein the switching element includes a pair of contacting electrodes disposed on the substrate and a mediating electrode which comes into a condition to contact with both of said pair of contacting electrodes to make an electrical conductive condition between said pair of contacting electrodes,

wherein said mediating electrode is disposed so that said mediating electrode is normally maintained to be contacted with neither of said pair of contacting electrodes, or contacted with either one of said pair of contacting electrodes, and when an external force with more than a predetermined strength is applied to the elastic deformable body, due to a deformation of the elastic deformable body, said mediating electrode comes into a condition to contact with both of said pair of contacting electrodes to select the detection mode, and

wherein a capacitance element is used as a force detecting element, and the detection circuit detects a capacitance value of said capacitance element as an electric signal, said capacitance element comprising a detecting fixed electrode provided on the substrate and a detecting displacing electrode provided at a position on the elastic deformable body which is opposed to said detecting fixed electrode and at which

a displacement occurs, the mediating electrode and said detecting displacing electrode being electrically connected, and the detection circuit has a function for detecting a capacitance value between a contacting electrode which is contacted with the mediating electrode and said detecting fixed electrode as a capacitance value of the capacitance element in the detection mode.

7. A force detector having a function for detecting a strength of an applied external force, comprising:

a substrate, an upper surface of said substrate being included in an XY-plane of an XYZ three-dimensional coordinate system having an X-axis, a Y-axis and a Z-axis;

an elastic deformable body which is disposed at a position opposed to the substrate, at least a portion of said elastic deformable body being made of material having elastic deformability, and said elastic deformable body displacing with respect to the substrate due to an elastic deformation caused by the applied external force;

a first force detecting element disposed between said substrate and said elastic deformable body at a position on an X-axis positive region and changes in a predetermined electrical characteristic due to a displacement of said elastic deformable body;

a first switching element located at a position outside of said first force detecting element on said X-axis positive region, said first switching element including a first pair of contacting electrodes and carrying out a switching function so that an electrical insulated condition is normally maintained between said first pair of contacting electrodes, and when an external force with more than a predetermined strength with respect to said X-axis positive region is applied to said elastic deformable body, an electrical conductive condition is obtained between said first pair of contacting electrodes in response to a deformation of said elastic deformable body;

a second force detecting element disposed between said

substrate and said elastic deformable body at a position on an X-axis negative region and changes in a predetermined electrical characteristic due to a displacement of said elastic deformable body; and

a second switching element located at a position outside of said second force detecting element on said X-axis negative region, said second switching element including a second pair of contacting electrodes and carrying out a switching function so that an electrical insulated condition is normally maintained between said second pair of contacting electrodes, and when an external force with more than a predetermined strength with respect to said X-axis negative region is applied to said elastic deformable body, an electrical conductive condition is obtained between said second pair of contacting electrodes in response to a deformation of said elastic deformable body;

wherein an electrical characteristic of said first and second force detecting elements is detected as an electric signal, when an electrical conductive condition is obtained on at least one of said first and second pairs of contacting electrodes.

8. A force detector according to claim 7:

the detector including a detection circuit for detecting a change in an electrical characteristic of the force detecting elements as an electric signal;

wherein said detection circuit selectively operates in two modes of a detection mode and a standby mode, said detection circuit performing a detecting function for outputting a change in said electrical characteristic as an electric signal when said detection circuit operates in said detection mode, said detection circuit maintaining a standby condition waiting for a transition to said detection mode without performing the detecting function when said detection circuit operates in said standby mode, a power consumption in said standby mode being less than a power consumption in said detection mode; and

wherein said standby mode is selected when both of the electrical conditions of the first and the second pairs of contacting electrodes are an insulated condition, and said detection mode is selected when an electrical condition of at least one of the first and the second pairs of contacting electrodes is a conductive condition.

9. A force detector according to claim 7:

wherein a pair of contacting electrodes included in a switching element are comprised of a contacting fixed electrode disposed on the substrate and a contacting displacing electrode disposed on the elastic deformable body, and when an external force with more than a predetermined strength is applied to the elastic deformable body, due to a deformation of the elastic deformable body, said contacting displacing electrode comes into physical contact with said contacting fixed electrode.

10. A force detector according to claim 7:

wherein a switching element includes a pair of contacting electrodes disposed on the substrate and a mediating electrode which comes into a condition to contact with both of said pair of contacting electrodes to make an electrical conductive condition between said pair of contacting electrodes, and

wherein said mediating electrode is disposed so that said mediating electrode is normally maintained to be contacted with neither of said pair of contacting electrodes, or contacted with either one of said pair of contacting electrodes, and when an external force with more than a predetermined strength is applied to the elastic deformable body, due to a deformation of the elastic deformable body, said mediating electrode comes into a condition to contact with both of said pair of contacting electrodes.

11. A force detector according to claim 8:

wherein a capacitance element is used as a force detecting element, and the detection circuit detects a

capacitance value of said capacitance element as an electric signal, said capacitance element comprising a detecting fixed electrode provided on the substrate and a detecting displacing electrode provided at a position on the elastic deformable body which is opposed to said detecting fixed electrode and at which a displacement occurs.

12. A force detector according to claim 8:

wherein a switching element includes a pair of contacting electrodes disposed on the substrate and a mediating electrode which comes into a condition to contact with both of said pair of contacting electrodes to make an electrical conductive condition between said pair of contacting electrodes,

wherein said mediating electrode is disposed so that said mediating electrode is normally maintained to be contacted with neither of said pair of contacting electrodes, or contacted with either one of said pair of contacting electrodes, and when an external force with more than a predetermined strength is applied to the elastic deformable body, due to a deformation of the elastic deformable body, said mediating electrode comes into a condition to contact with both of said pair of contacting electrodes to select the detection mode, and

wherein a capacitance element is used as a force detecting element, and the detection circuit detects a capacitance value of said capacitance element as an electric signal, said capacitance element comprising a detecting fixed electrode provided on the substrate and a detecting displacing electrode provided at a position on the elastic deformable body which is opposed to said detecting fixed electrode and at which a displacement occurs, the mediating electrode and said detecting displacing electrode being electrically connected, and the detection circuit has a function for detecting a capacitance value between a contacting electrode which is contacted with the mediating electrode and said detecting fixed electrode as a capacitance value of the capacitance element in the detection mode.